Thurston Net Gain Project - Technical Overview

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Introduction

Thurston County has approximately 180,000 acres of Riverscape. It has taken six to eight generations of widespread public and private land-use practices to clear forests, ditch watersheds, and depress fisheries, leaving riverscape processes fundamentally modified at a landform scale. Although many historically intensive land uses have stopped, pollution, high flood flows, drainage systems, and invasive species continue to impact this landscape. Thurston Conservation District is among the leading restoration actors in the county, working on 30-40 new acres a year with restoration treatments that may take seven to ten years of maintenance before we can assume a change in ecosystem services.

Given the distance between the scale of ecosystems and the current scale of our efforts, we propose that to achieve broadscale improvement of ecosystem services will require the voluntary participation of public and private parties as part of a large-scale shift in the management of our lands and waters.

The Millenium Ecosystem Assessment recognizes four kinds of services people get from ecosystems: provisioning—the direct harvest of materials like food fiber and fuels; regulating—the way that ecosystems regulate the cleanliness of water, storage of carbon, or reduction of floods; cultural—both recreational, aesthetic, and spiritual; and supporting—which are all the little functions that make the other services possible.

This project aims to normalize increasing ecosystem services as a project worthy of collective effort and community investment. We will propose a framework for visualizing and quantifying the stewardship of ecosystem services in Thurston County. The framework is aspirational, in that we aim to describe historical losses of ecosystem services while identifying opportunities to increase ecological wealth and wellbeing for residents over generations.

Tracking the gain or loss of ecosystem services over time is a fundamental challenge of ecosystem planning. Our laws, elected officials and residents ask simple and important questions about the public trust, such as, what do we need to do, how much do we need to do, how are we doing, and are we doing enough?

Existing authorities and programs manage individual elements of the ecosystem, but there is not a mechanism for integrating the observations of federal, state, local and private partners into a coherent synopsis of ecosystem conditions. Regional dashboards (for example State of the Sound or Puget Sound Vital Signs) provide important context, but do not always relate to our actual local issues.

This project recognizes that quantification is a necessary first step to track progress across this range of authorities, and to answer the public's questions with a high degree of accountability. Quantification sharpens our analysis and helps identify areas of agreement, disagreement, and uncertainty. Quantification can force us to explain where we believe we have evidence, where we are making reasonable presumptions,

and where we may lack evidence. In this way, a quantification framework will not only serve as a decision support tool but also serve as a way of organizing and synthesizing information over time.

This project is in part inspired by the Kitsap County Natural Asset Management Program. During development, we spoke with staff, consultants, and partners with the goal of learning from their pioneering work and applying relevant lessons to Thurston County.

Our approach is human-centered, recognizing specific ways that humans benefit from high-functioning ecological systems. Human values are not limited to the reaping of products in an economy. We also aim to recognize the social and spiritual values that come from tending and protecting ecological richness as cherished and sacred. These non-materialistic values are reflected in our legal code, and thus in this ecosystem analysis.

This framework is not intended as a universal methodology that can be applied to any place. It is designed around the unique ecological wealth of the finger inlets and outwash plains of South Puget Sound and the Chehalis Divide. It is grounded in the particular lands, waters, ecosystems, and communities of Thurston County. This local specificity is an important part of our analysis.

This initial document introduces our purpose and approach, the five domains in which we plan to estimate potential ecosystem services, a strategy for organizing information and visualization, and a general sequence of work.

Purpose and Approach

This project aims to build a versatile accounting of natural assets and their level of service at a countywide scale. Natural asset accounting can support decision making in a similar way to financial accounts--we can evaluate the costs of alternatives, set targets and budgets, and describe accomplishments over time within a relevant context.

We are NOT converting ecosystem goods and services into monetary currencies. Ecosystem goods and services are not easily convertible, come from a finite basis (the earth), are difficult to replace, carry cultural and spiritual values, and are managed under the public trust doctrine. Attempting to reduce natural assets to cash equivalents is neither proposed nor advisable and distracts from our primary objective of increasing stewardship and thereby increasing ecosystem services.

We aim to simplify the complexity of ecosystems to organize our thinking and help staff in planning agencies provide information to support decisions. Ultimately this is a teaching and analysis tool that could be used within partner agencies, or to help citizens and their leaders better understand the challenge of ecosystem stewardship. This tool will rely on data that may be old, or ecosystems as seen from an airplane. These representations of ecosystems are not intended to replace the site-specific analysis or field work necessary to understand the nuances of specific places.

We are NOT developing a regulatory model that determines what you can do with your private property. The development of regulatory tools is a more intensive process, by a specific agency, using definitions and precedents from specific laws or regulations. The information a government uses to affect private property rights is a very serious project. We aim to generalize broadly across many authorities to provide a holistic and integrated assessment of a portfolio of services. We hope to inform decision making by elected officials, improve coordination within and among governments, track progress towards shared goals, and compare the effects of alternatives.

We do propose the use of a habitat equivalency approach that is able to support a "service-to-service" valuation of gain or loss of ecosystem services (NOAA, 2000; Dunford et al., 2004). Equivalency analysis methods use a service-acre approach. Each acre gets a score of 0-1 that describes its level of service. These methods are simple enough to manage with a spreadsheet. They are designed to be transparent, adaptive, and used as a basis for negotiation. They have been subject to independent national peer review as the application of best available science (NMFS, 2024). Our aim is to develop an accounting approach that creates value in public policy debate and that has the transparency and accountability of rigorously tested national methods.

We are aiming for a "service acres" approach because it is:

1. **Technically sophisticated without being a "Black Box"** - using "service acres" is an accessible approach for non-specialists while still retaining sufficient details for expert review and spreadsheet-based calculations. It allows users to discuss, 1) how site conditions affect service level, and 2) how a change in area and service level may increase or decrease "service acres". Calculating service acres also requires users make explicit judgments about relative importance of various indicators, revealing whether there is agreement, disagreement, or uncertainty. This transparency has social benefits for a community as it creates a basis for deliberation, supporting the identification of gaps and guiding prioritization.
2. **Adaptable and Interactive** - Service acre calculations can be used to summarize services at a landscape scale, incorporating diverse ecological units (e.g. beach service acres). However, the underlying data can also be used to produce a more easily understood dashboard of metrics (e.g. percent armoring). The calculations that define service level can be adjusted in a modular manner and re-run as new evidence emerges. Service model structures can be used to help organize complex evidence about ecosystems, so it is more easily reviewed, understood, and communicated. In addition, service acre analysis is capable of easily incorporating time, including the gradual recovery of ecosystem services and interim losses as part of evaluation of gains and losses—making it "transaction ready".
3. **Spatially Explicit and Scale Agnostic** – A service acre approach can be summarized at any scale using any management unit, preserving flexibility and supporting scenario analysis. It avoids the limitations of relying exclusively on watershed boundaries, which are not always appropriate for evaluating ecosystems like forests or prairies that have biogeographic functions at scales not defined by watershed. This method is scalable and can be used for calculations in large landscapes or many different smaller scale units without modifying the underlying assumptions and methods for calculating ecosystem services.

The goal of this project is for any party to be able to review available evidence of a change in land use or stewardship, use the framework to understand the potential gain or loss of ecosystem goods and services, and make a claim about the scale of that change, and compare the scale of effect from different choices. Gain or loss is determined by using before-after scenarios using transparent and repeatable methods (Figure 1).

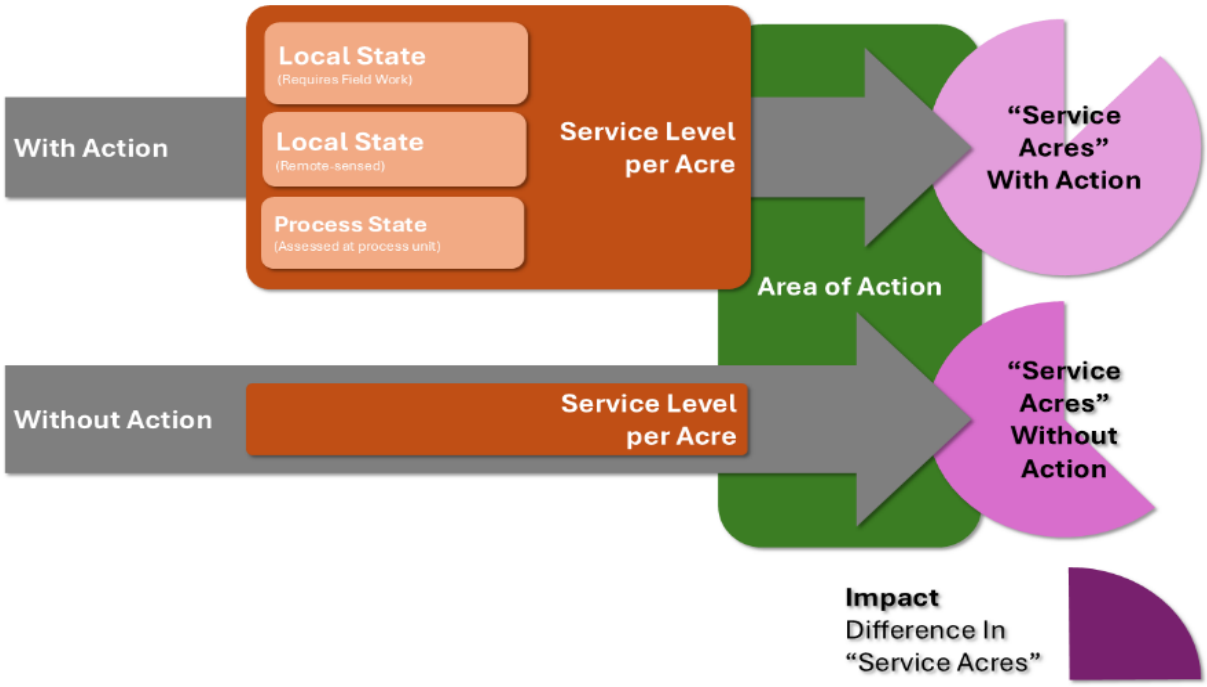


Figure 1 – Service Acre Model. Change in services is evaluated by comparing "service acres" produced with and without an action or over time. Service can increase by increasing service level per acre. This might include bringing new areas up from a service level of zero. The impact of an action (net gain or loss) is determined by comparing "service acres." The total area of the action remains constant as a control on evaluation. Assessment may be completed at a site, landscape or watershed level, depending on purpose or scale of action. Service level is determined by observation of state (indicators). Service level can integrate remote sensing, field work, and evaluation of landscape conditions. Within any area, indicators can be used as a dashboard independent of service value to deconstruct service acre calculations.

Five Ecological Domains

We identify five distinct ecological domains to organize analysis: forests, riverscapes, coastlines, prairies, and foodscapes. Each sub-system represents:

- A specific set of authorities and obligations
- Distinct ecological systems providing distinct services
- A "setting, characters, and plot" for storytelling
- A body of community of expertise, data, and ongoing work

Within each domain we work from local planning and regulatory documents to identify ecosystem services that are of concern to the public trust. These include both regulatory authorities and the aspirations of local, state, and federal planning efforts.

These domains overlap in the real world. Prairie frequently overlaps agriculture as grazing lands that were once prairies and have appropriate soils for cultural burning. Agriculture frequently overlap riverscapes, as farmers seek the moist fine-textured soils of floodplains and wetlands. Riverscapes overlap coastlines where rivers affected by watershed conditions spill into estuarine waters. Forests encompass large areas that include riverscapes and encroach on prairies.

These five domains are not distinct land units. Forests are not separate from riverscapes—in fact they overlap. They are five lenses for evaluating ecosystem services. The same land unit may provide riverscape services and forest services. A change may increase services through one lens and decrease services

through another. These are five tools for organizing our evaluation approach—these are five different ways of measuring ecosystem service potential across the same land base. They are organized using a land cover and landform nomenclature, because services often flow based on landform and landcover.



Forest Services – Forests are large contiguous areas of native tree canopy. These may be conservation preserves or working forests, with a variety of age structures. Forests offer unique ecosystem services related to timber and non-timber provisioning services, providing terrestrial wildlife islands and corridors that support biodiversity, opportunities for hunting, and varied levels of fire resilience, as well as serving as a globally important carbon sequestration site. Forests have overlapping effects that help regulate riverscapes. Forests tend to encroach on Prairie. They are cleared for Agriculture. Forests are regulated under county zoning, state forest practices, federal habitat conservation plans, and other authorities.



Riverscape Services – Riverscapes describe the movement of rainwater over land and in shallow groundwater, including streams, rivers, wetlands, and fresh waterbodies. In most cases, these form a network of hydrologically overlapping and interconnected features. In the case of some wetlands, they may be more isolated. Riverscapes provide recreation and food and affect coastlines through water quality. They recharge groundwater and thus determine all water availability over time. Riverscapes are managed through a complex mix of authorities and rights governing wetlands, streams, rivers, water quality, and water quantity, including beneficial use rights.



Coastline Services –Saltwater coastlines include beaches, and various embayments and estuaries, such as tidal wetlands. They are commonly sustained by coastal erosion and wave energy or by stream and river inputs of sediment and freshwater, in conjunction with daily tides. They are highly valued for real estate, provide fish and wildlife habitats, sustain unique biodiversity, and support regionally significant aquaculture. They are highly regulated under state, federal and local law, with strong protections for ecological functions, and are a focus for tribal trustee obligations. Large scale water quality challenges such as nutrient loading and eutrophication present a challenging backdrop to management. We use “coastline” rather than shoreline to avoid language that overlaps with regulatory definitions.



Prairie Services – The South Sound has a globally endemic and anthropogenic oak prairie vegetation that includes ESA listed species and tribal heritage agroforestry systems. They evolved over thousands of years under tribal tending and a cultural burning regime. In spite of agricultural and residential development, a small fraction of high-quality examples remains. Prairie-Oak ecosystems are defined by soil, vegetation, and distribution of protected gophers, butterflies and birds. These systems are regulated under local land use with state and federal interests, including a County-led Habitat Conservation Plan.



Agriculture Services – Local food production includes grazing lands, hay production lands, crop production systems, marine aquaculture, and a handful of remaining dairies. This analysis focuses on how land units in the county enable a resident to sustain economic and household food production, including soil conditions, infrastructure, and the organization of the social, economic, and cultural resources necessary for food production. Agricultural service analysis is unusual because agricultural services depend on the steward, and thus agricultural services require both ecological and social conditions to be protected. In addition to production, agricultural lands have the potential to produce food and other products, and provide open space, flood hazard reduction, and recreation. They are essential for life. Regulation in

foodscapes can overlap with riverscapes and prairies, while a variety of regulatory exceptions to support food production increase regulatory nuance.

Methods

We aim to answer the following questions:

1. **How do we estimate current ecosystem services compared to historical levels?**
2. **How are ecosystem services likely distributed in the landscape?**
3. **How can available evidence be used to estimate changes in ecosystem at a site, landform, or watershed scale?**
4. **How can fieldwork complement remote sensing data to better inform estimates of ecosystem service level?**
5. **Where are the critical information gaps that limit our ability to manage ecosystem assets and preserve the delivery of ecosystem services over time?**

The project will go through, 1) a period of conceptualization, 2) technical development and, 3) testing and experimentation over a 9-month period, with the aim of developing a proposal for five ecosystem service quantification models that could be applied at a county scale.

Conceptual Foundations

A model conceptualization process aims to capture knowledge and experience of community members, while maintaining an accessible visualization tool for each of the five domains. Precision of language supports understanding. We aim to integrate three existing and complementary approaches to ecosystem assessment and management as we build our conceptual framework:

Simenstad et al. (2006) Process-Structure-Function model– An independent and interdisciplinary science team developed a framework that acknowledged the critical role of nearshore ecosystem processes in maintaining and shaping desired habitat structures and functions. This is consistent with an evolving body of "process-based restoration" theory encompassing floodplain dynamics (Naiman et al., 2010; Clure & Thorne, 2014), across process domains of the river continuum (Montgomery, 1999) and in fire landscapes (Agee, 1993; Dunwiddie & Bakker, 2011).

Ecosystem Services Categories – We reference the catalog of the Millenium Ecosystem Assessment (MEA, 2005) which describes how human society gets value from ecosystems. It discriminates between provisioning (the products directly obtained such as food, water, materials, and medicines), regulating (the benefits from a regulated ecosystem, including climate, clean water, flood and storm resilience, and disease and pest regulation), cultural (the non-material benefits, including recreational and aesthetic, spiritual and religious, and education and inspiration) and supporting (the services that enable other services, such as soil, nutrient cycling, and primary production).

Drivers-Pressure-State-Impact-Response (DPSIR) model – A broadly adopted model for mapping linear effect chains or effect pathways for the purpose of conservation planning (Smeets & Weterings, 1999). Adopted by EPA and the Puget Sound Partnership to support regional planning (PSP, 2022). In general, we define "state" in terms of structures, processes, and functions that provide services. Human activities that affect state for good or ill are our "pressures." States and pressures provide our pool of potential leading and

lagging indicators. We put ecosystem services in the "impacts" position, as the services we desire, and that may be gained or lost as pressures work on states.

Model Elements, Relationships and Visualization

Our models are built from box-and-arrow diagrams that show how indicators (ecosystem states) affect services—boxes present elements, and arrows show relationships. We want to create a web-accessible platform that allows collaborators to see our list of elements and relationships and their definitions, and to be able to visualize the web of relationships that control ecosystem services. This platform should support continuous update, high levels of visibility and flexible visualization. We will use the Kumu Platform, using linked Google Sheets as a dynamic and accessible integration that supports these capabilities at a minimum of cost.

Within each domain, we will identify ecosystem services that have a public trust nexus. For each ecosystem service, we will use existing planning and analytical products, together with expert elicitation, to identify indicators that can help estimate ecosystem service provision (States in the DPSIR framework). We will also identify the most common pressures which can increase or decrease indicators.

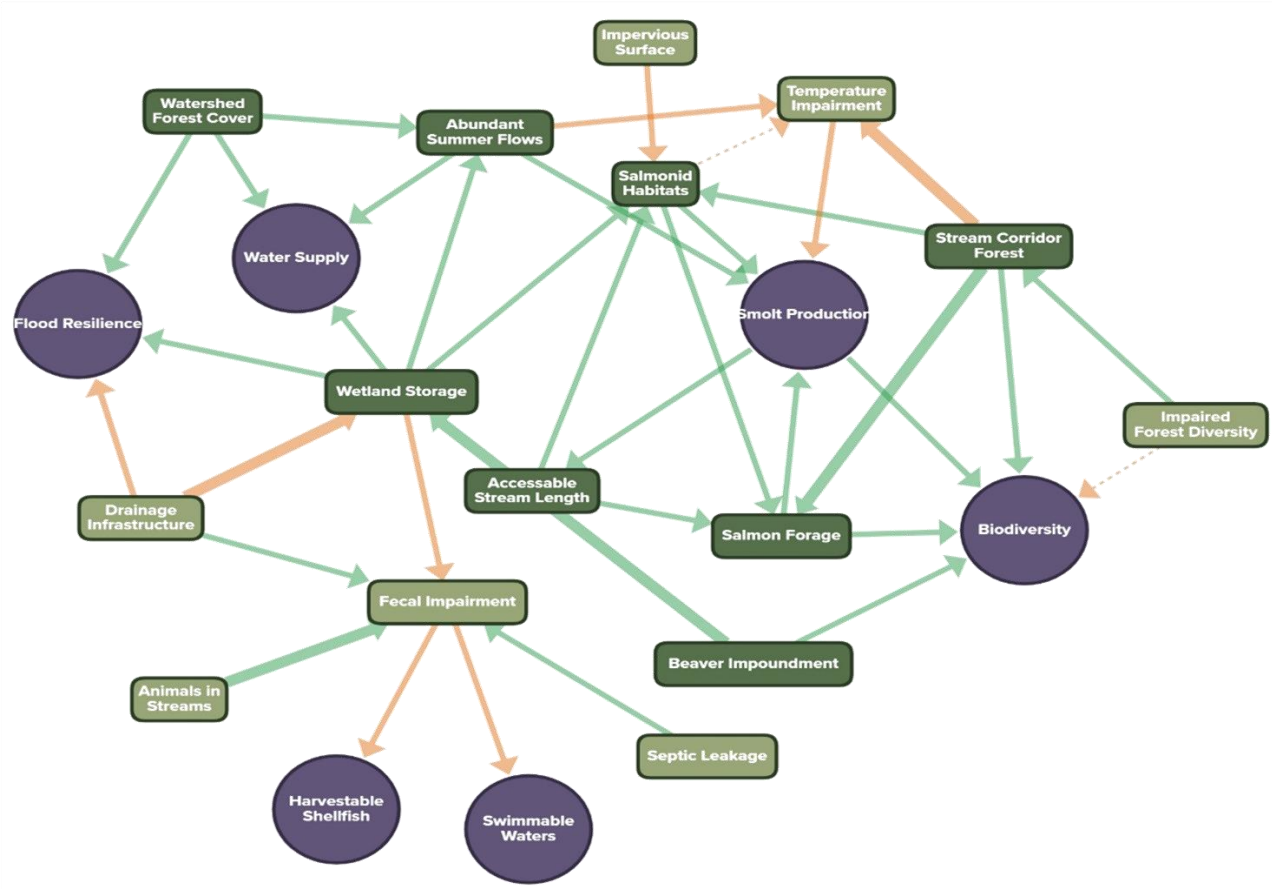


Figure 2 – Draft Riverscape Conceptual Model as Example – Purple circles show ecosystem services. Green rectangles show indicators of ecosystem state proposed to affect either ecosystem services or other indicators. Arrows show how one element increases (green) or decreases (orange) another element. Ecosystem states may affect more than one service. Services are affected by more than one ecosystem condition. This conceptual model serves as the basis for developing a rubric for setting ecosystem service value within a polygon. All labels, definitions, and related information are derived from a google sheet. Both the sheet and diagram can be accessed by collaborators through a web-accessible interface.

This set of indicators of states, and impacts to services is built into a model by proposing causal relationships. This is presented as a set of "claims" that a change in one element may cause an increase or a decrease in another element. An accompanying Google Sheet provides additional context about each element and relationship. These definitions and proposed relationships can be viewed through the visualization tool or directly in the Google Sheet, allowing users to simultaneously evaluate and comment on the draft product.

Service Units and Deliverables

Parallel to the conceptual modeling we will be evaluating best available spatial data to define polygons in the landscape where services are provided. Other sources of data may describe the conditions of these polygons and represent our conceptual indicators.

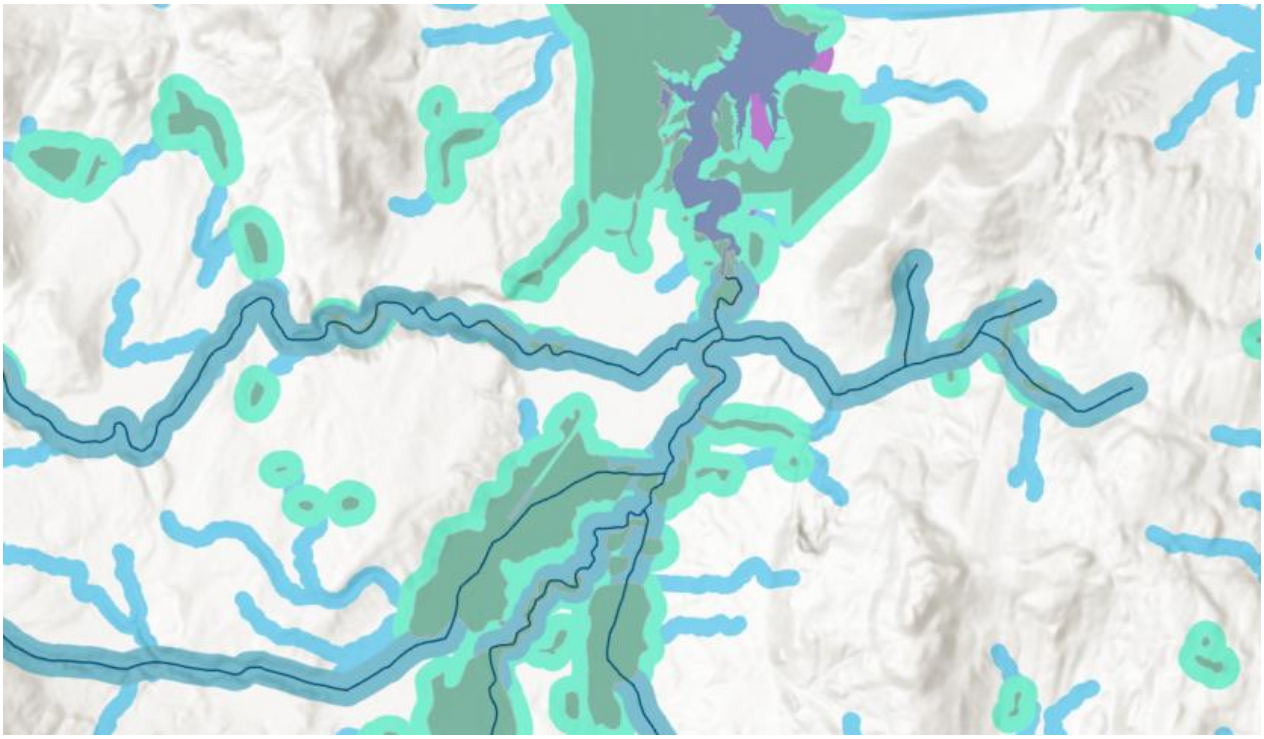


Figure 3 – Proof of concept for riverscape service units. Features and landforms where services are provided can be represented as polygons with a known acreage. A service-acre approach would evaluate the quantity (acres) of riverscape, and the quality (level of service) of riverscape services within each acre. A change in area or level of service results in a change in Riverscape Service-Acres. This same method can be applied at a site or landscape scale.

We are completing a "framework development" project. Conceptual model development, the results of data discovery, and model prototypes will be offered to our broader community as a proposal for ecosystem service quantification. The project final report will offer a roadmap to development of these tools, and a report of our findings, questions, and concerns. The final report and supporting deliverables, model data and supporting materials will be archived using the Salish Sea Restoration Platform.

Community Approach

Our aim is to capture and incorporate a wide range of thoughts, questions and concerns from our broader community in developing this proposal. Project products will be available during development, and we will create diverse opportunities to incorporate the evidence and values of participants.

At the beginning of the project, we will initiate tribal consultation and provide specific opportunities for tribal review of models and methods. TCD and Thurston County will jointly send letters of introduction to each of four tribal councils and natural resource departments (Squaxin Island, Chehalis, Nisqually, and Quinault). Tribal representatives will be invited to identify a level and form of engagement that aligns with their interests and priorities. This effort aims to clarify resource management under federal, state, and local obligations, including tribal trust responsibilities, but is not intended to represent the positions or claims of tribal governments. We also understand that these efforts may or may not include all evidence held by tribes, which will be shared at the discretion of tribes.

Through one-on-one and small group interviews with local professionals and practitioners within each of our five domains we will test and refine our model elements and connections, and incorporate their professional judgement. We will use an informal snowball approach, working from an initial list of contacts created by County and TCD staff, and asking for recommendations for informants at each interview. The expert elicitation process will expand or refine our set of claims while beginning to assemble evidence needed to support quantitative estimates of ecosystem service provision. Final documentation will summarize rationale and supporting evidence, as well as organize the remaining work necessary to advance model development.

We anticipate the project will result in a portfolio of research that may improve our ability to quantify ecosystem services. Research will prioritize areas of greatest uncertainty about how indicators influence ecosystem services. Topics may include:

- Relationship between indicators and ecosystem services.
- Methods for estimating ecosystems services.
- Interactions among indicators.
- Variation in service level based on spatial data.
- Thresholds and nonlinear relationships between indicators and ecosystem services.

After an initial round of expert elicitation and tribal consultation, we will offer a series of workshops that present our refined model results for the following ecosystem management stakeholders:

- Water Resource Inventory Areas (WRIAs) 12, 13, and 22/23
- Alliance for a Healthy South Sound
- Thurston County Agricultural Advisory Board

Over the course of the project, we will also offer public presentations that will be recorded and posted online to broaden access to project findings. This initial effort is being developed using grant funding from Washington State Department of Commerce and is constrained by time and capacity. Our methods aim to maximize our exposure to a range of evidence and opinions.

Early Notes on Technical Development

Separating ecosystem service estimates across multiple domains supports more nuanced analysis and clearer communication. Ecosystem service competition between domains can be at the root of existing social and political conflicts and may be unresolved in foundational planning efforts. For example, the Thurston County comprehensive plan contains policy goals around both the preservation and expansion of farmlands, and the preservation and expansion of wetlands. Thurston County's "prime farmland under protection" does not include "prime farmland if drained", because it is "unlikely to be drained in the future" referencing the regulatory complexity of maintaining or increasing farm drainage in wetlands. However, an

adjoining section states agriculture “could have an additional 48,000 acres with proper drainage.” These natural tensions between riverscape services and agricultural services are delegated to voluntary programs that "promote the long-term viability of agricultural activities while protecting and enhancing critical areas" (Thurston County, 2025). Our approach aims to support consideration of the diverse services provided by riverscapes, and support discussion of desired future conditions.

We anticipate quantifying ecosystem service levels as a proportion of the specific services that could be provided by an ecosystem in an optimal condition. However, an optimal condition may not be a desirable target or feasible under existing conditions, and optimal conditions for one set of services may be less than optimal for another set of services

Our service-value approach assumes that gain or loss of services is incremental and based on incremental change in indicators. However, we are aware that the ecological literature shows that loss of services can be sudden as conditions cross a threshold. We aim to identify potential risks of abrupt changes when ecological thresholds are crossed. Identification of thresholds can and should be incorporated into models that support ecosystem management.

In some cases, landscape- or catchment-scale conditions may increase or decrease the ability of a local unit to produce ecosystem services. Landscape or catchment scale loss of services may affect service level at a specific site. For example, habitat fragmentation or large-scale changes in water quality or quantity may affect service provision within an entire stream reach, even if local habitat conditions remain unchanged. Where evidence is available, summary statistics at a landscape or catchment scale can and might be used to adjust service level at individual sites.

This project aims to provide an estimation tool for reporting restoration effort in Thurston County. Many ecosystem services are based on nuanced local conditions. For example, the actual level of water quality “services” are greater at a site where upstream water quality degradation can be corrected, compared to a site where water quality is already high. We anticipate a feasible model will be estimating change in “service potential” rather than actual realized change in services.

Site-specific local regulatory analyses and models are the appropriate tools for identifying and evaluating individual project value and feasibility. For example, a water temperature violation may trigger a Total Maximum Daily Load (TMDL) analysis which uses intensive stream modeling and field investigations to identify targets for reducing temperature loading. Our analysis may inform our general understanding of ecosystem services, but this proposed work does not replace or circumvent the need for robust analysis required under regulatory processes. Wherever possible, robust and detailed analyses, such as those completed under water quality and salmon recovery authorities, are a preferred basis for localized planning and agency determinations.

The developed landscapes prevalent in urban growth areas may provide some level of services within these five domains. Urbanized patches with low ecosystem function may contain important islands of ecosystems services, such as parks, urban forests, or wetlands and stormwater infrastructure that provide specific services. However, for example an urban forest patch is unlikely to provide the full range of forest services found in large, mature forest areas. While our methods will be useful for quantifying service levels, it will not provide the social and political judgements necessary to determine if a given set of services are exchangeable or equivalent.

Technical development will use best available spatial data to define unit boundaries for each domain— areas where we anticipate that land use strongly influences potential ecosystem service provision. These spatial

units will provide a basis for evaluating indicators and quantifying service levels as service acres. Based on a simple metric evaluation, service level may be presented as a unitless "service-acre" parameter useful for scenario analysis and comparison at multiple scales. The same data sources may also be represented through an accessible dashboard of indicators. Where evidence is not available to set quantification of metrics and thresholds, we will use best professional judgement and non-parametric ranking methods and rank-sum strategies to explore service level calculation. These methods will be documented to support transparent results.

How You Can Engage

Thurston County and Thurston Conservation District will be seeking input from subject matter experts, and through workshops. We will make our work products publicly accessible and provide opportunities for comments. Our aim is to capture the evidence, questions, thoughts and concerns of our community and incorporate those into a proposal for developing an ecosystem service accounting system that can support public discussion and evaluation of policies and activity.

If you would like to receive updates from the project team, please use this SmartSheet Form to sign up for our mailing list. For any other concerns or questions please contact Paul Cereghino, TCD Habitat Program Manager (paul@thurstoncd.com) or Andrew Deffobis, Thurston County Senior Planner (Andrew.deffobis@co.thurston.wa.us).

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